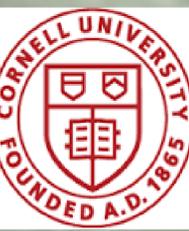
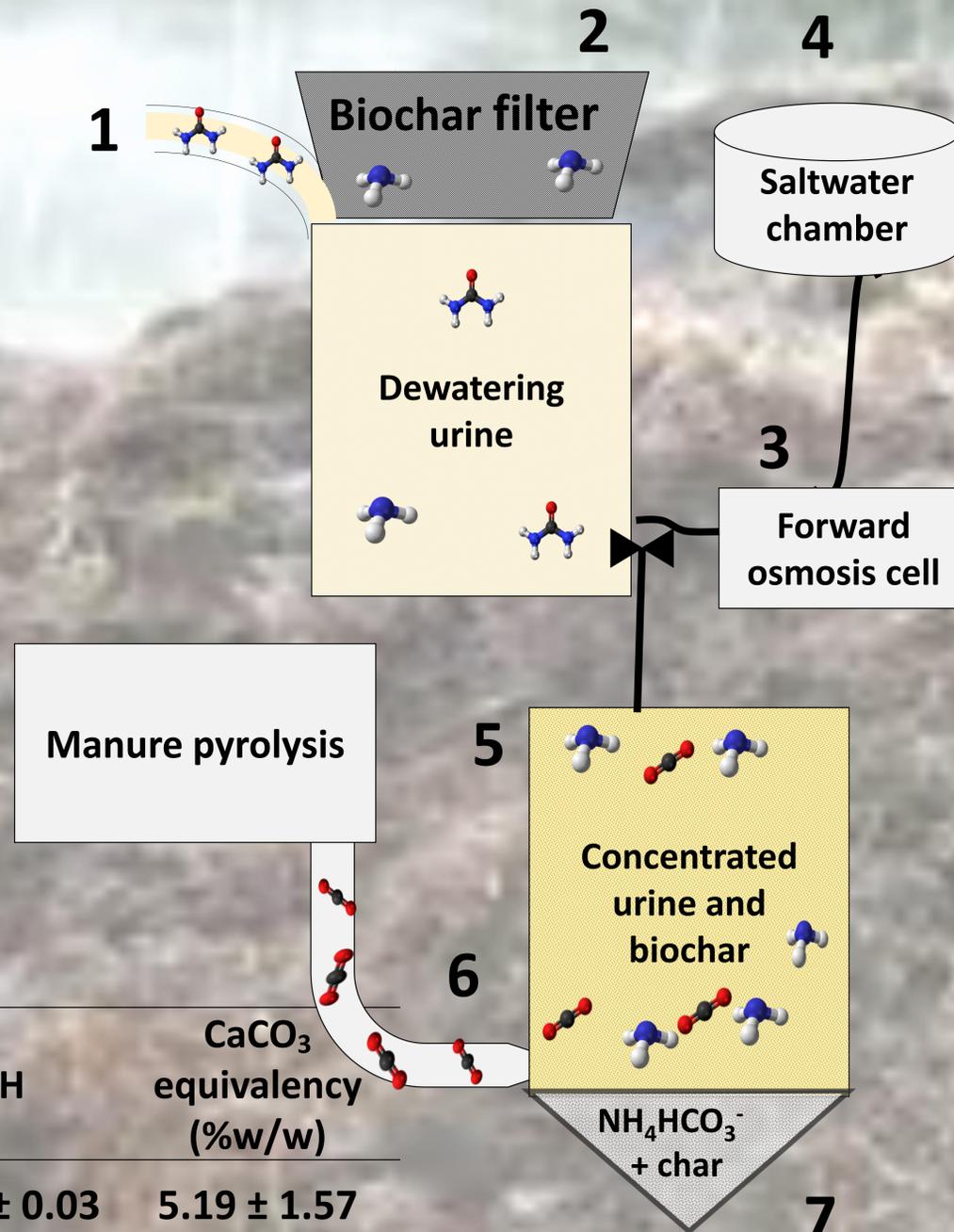


Utilizing products of manure pyrolysis: biochar and carbon dioxide, to precipitate mineral nitrogen fertilizer from urine

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- Pyrolysis > 300C converts manure into 50% biochar and 5% carbon dioxide
- Biochar supplies phosphorus, stable carbon, and buffers soil pH
- Carbon dioxide is used to precipitate ammonium bicarbonate from urine
- A dewatering process such as forward-osmosis is necessary for precipitation



- ### Steps in urine precipitation
1. 10 L urine inflow containing ~50 g $\text{NH}_{3,4}\text{-N}$
 2. Adsorption of ~5% $\text{NH}_3\text{-N}$ by biochar filter
 3. Forward osmosis to dewater to 1L
 - a. urine is 'feed' solution
 - b. saltwater is 'draw' solution
 4. Exacting high osmotic pressure
 5. Concentrated urine and biochar suspension
 - a. 1L urine : 250 g biochar per batch
 6. Sparging of pyrolytic- CO_2 to capture 80% urine-N
 - a. 1 mole CO_2 : 1 mol $\text{NH}_{3,4}$
 7. Precipitation of ~ 40 g $\text{NH}_4\text{HCO}_3^-$ on 2.5 kg char

Pyrolysis temp. (°C)	Phosphorus (mg kg ⁻¹), Mehlich-III	Stable carbon after 100 yrs (%w/w)	pH	CaCO ₃ equivalency (%w/w)
300	8705.71 ± 33.69	44.11 ± 2.09	8.83 ± 0.03	5.19 ± 1.57
400	9995.56 ± 11.65	60.54 ± 0.60	10.30 ± 0.01	7.96 ± 0.79
500	10243.70 ± 1405.36	77.07 ± 3.40	10.72 ± 0.01	8.52 ± 0.52
600	10586.24 ± 309.07	85.19 ± 0.93	10.26 ± 0.01	7.41 ± 0.52
700	11523.47 ± 159.33	92.88 ± 1.03	10.76 ± 0.06	9.25 ± 0.52

